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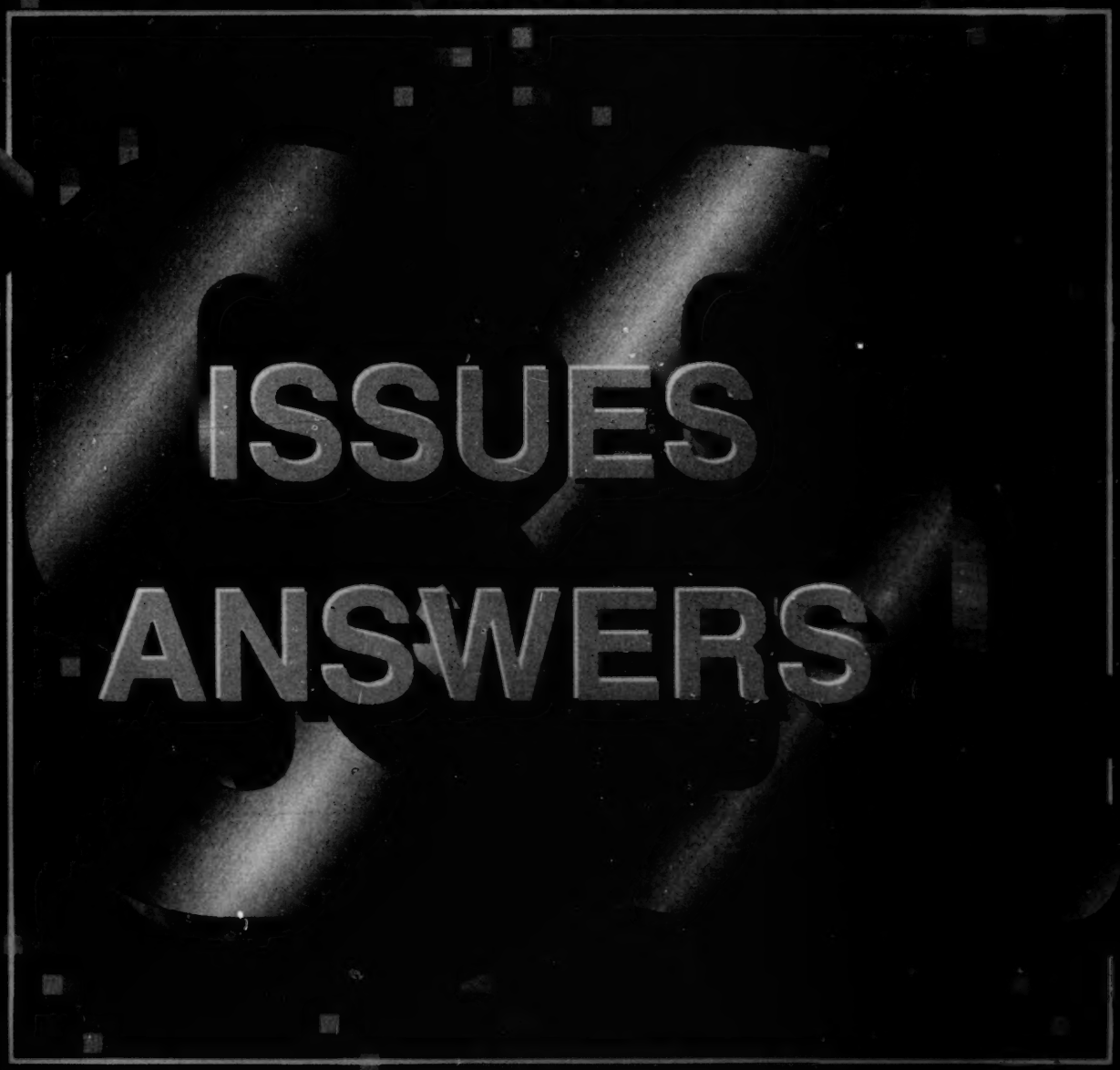
FOOD ENGINEERING

SINCE 1928, THE SOURCE ON PROCESSING, PACKAGING AND PRODUCT DEVELOPMENT



FOOD ENGINEERING

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The '90s are almost here. Being ready for them is the processor's next major imperative.

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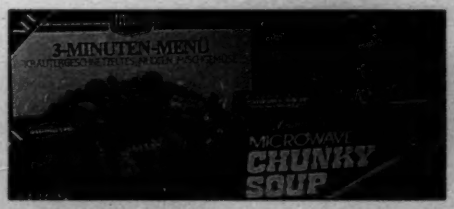

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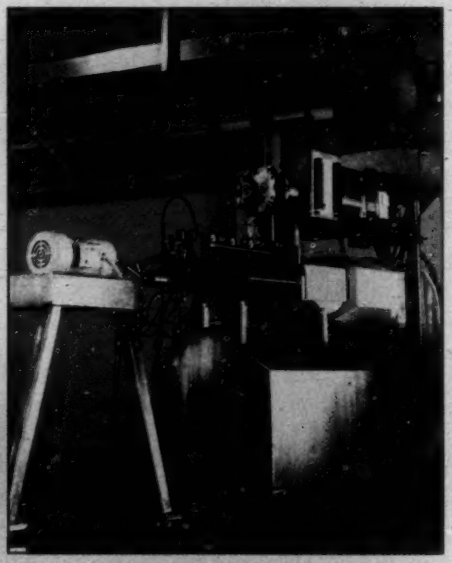

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COOKING AND HEAT EXCHANGE

Processors are seeking cooking methods that offer alternatives to canning and hot filling, while at the same time offering products that meet consumer standards.

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PACKAGING FACES NEW ISSUES

Packaging for "market-driven" products may be solving marketing problems such as added convenience and freshness, but it's raising issues about food safety and the environment.

CHARLES E. MORRIS
Midwest Editor

Almost every "answer" to a food-packaging issue seems to raise yet another issue. Most current packaging issues concern plastics. Some major issues for the 1990s, as perceived by *Food Engineering*:

- Plastic packaging answering consumer demands for convenience and "freshness," as well as packer needs for extended shelf life and lower distribution costs, is raising issues about the solid waste stream.
- Retortable and aseptic products in rigid barrier-plastic containers have raised the issue of assuring seal integrity on-line.
- Controlled atmosphere packaging (CAP), aimed mainly at extending refrigerated shelf life of fresh meats, poultry and seafood, raises microbiological safety and plant-sanitation issues.
- Packaging materials for microwaveable foods are raising regulatory concerns. (Example: As this story went to press, FDA had scheduled a public meeting for September 22 in Washington, DC to address its concern with susceptor materials.)

The six-month cruise of the garbage barge *Mobro*, shown moored with its tug to an oil rig off Grand Isle, LA, focused public attention on the solid-waste crisis last year. Nobody would accept the scow's 3,000 tons of garbage from Long Island, where landfills were full. (Source: UPI/Bettmann)

Garbage glut

"Disposability" was once a packaging advantage. Not any more. The nation is running out of space for municipal landfills, the standard method of garbage disposal. Municipal landfills declined in number from about 18,000 in 1979 to little more than 6,000 today, and half of these will be filled up or shut down for environmental-contamination reasons by 1990. Siting new landfills encounters regulatory prohibitions and community opposition. State legislators are drafting bills ranging from a ban on plastic packaging that is not biodegradable or recyclable (California) to tax credits for recyclable and recycled materials (New York). Only 10 percent of municipal waste is incinerated. Reason: Nobody wants a municipal incinerator in *his* community.

And so, solving the solid-waste crisis looms as the overriding packaging issue of the 1990s.

According to a 1986 study conducted for the EPA by Franklin Associates, the nation's solid waste stream in 1984 weighed in at about 133 million tons, after 15 million tons (mostly newsprint and corrugated) had been recycled. Containers and packaging accounted for 32.7 percent, or nearly one-third of the total. Of this packaging waste, 47.8 percent was paper, 27.1 percent glass, 11.5 percent plastics, 6.4 percent steel, 4.6 percent wood, 2 percent aluminum and 0.6 percent miscellaneous. Although plastics accounted for only 7.2 percent of the total solid waste stream—probably far less than the public perception—that translates into 9.6 million tons and rising. Plastic waste is projected to reach 9.8 percent of the solid waste stream by the year 2000.

Experts agree that the solutions must combine several approaches, "an appropriate balance of reduction, recycling, waste-to-energy incineration, landfill and

Microwaveable entrees and other convenience foods are starting to proliferate in retortable barrier plastic containers. (Source: EVAL Co. of America)

developing creative concepts and technologies," said Karl W. Kamena, director of government affairs for the plastics group at Dow Chemical USA, at Barrier Pack '88 May 18 in Chicago. Kamena envisions the profit motive driving both incineration and recycling of plastic waste. Plastics at 7 percent of the solid waste stream account for 25 percent of the energy recoverable from the waste stream, he pointed out. "It doesn't cost money to incinerate plastics, it *makes* money," he added.

Recycling plastics is more controversial, Kamena continued. But technology is less a deterrent to recycling than:

- Developing an infrastructure to collect post-consumer, potentially-recyclable waste feed,
- Developing useful products and markets for recycled plastics, and
- Making recycling profitable.

Kamena suggests reducing recycling costs by awarding a "cost-avoidance value"—money saved by not disposing of the product—to source-separated recycled products. "The $64,000 question, of course, is: Who gets to pay this cost-avoidance?"—industry or some level of government?"

The biggest recycling success story since WWII is that of the aluminum can, where a 20-year effort led by Reynolds and Alcoa now boasts a recovery rate of 50 percent. Glass manufacturers, through a multi-million dollar employee-funded effort launched in 1980, have boosted glass-bottle recovery to 12-15 percent and growing.

Industry and academe are both attacking the plastic waste problem. Last January, the soft-drink industry formed the National Association for Plastic Container Recovery (NAPCOR), which hopes to boost recovery and recycling of PET soft-drink bottles to 20 percent (to 30 million lbs.) this year and to 50 percent by 1992. Recycling research is under way at Rutgers, Michigan State, the Univ. of Toledo, and the New Jersey Institute of Technology. The Council & Plastics Packaging in the Environment, the Polystyrene Packaging Coalition, the Society of the Plastics Industry, and the Foodservice & Packaging Institute all have task forces addressing the solid-waste issue.

One interesting idea is to emboss plastic bottles and containers with a code indicating resin type to help recyclers identify and segregate plastics for recycling. Several states are considering such a law. Another creative (no, destructive) approach: plastic films and sheet incorporating corn starch to render them biodegradable. Starches for this application were recently introduced by St. Lawrence Starch Co. (Mississagua, ON) and ADM (Decatur, IL). The Illinois legislature recently passed a bill requiring landfills to accept yard waste only in biodegradable plastic bags incorporating at least 6 percent corn starch. (At this writing, Governor James Thompson had not yet signed the bill into law.)

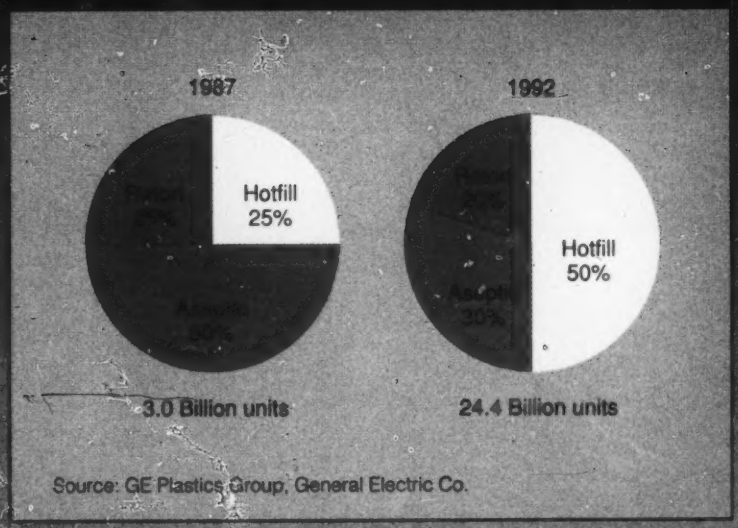
But solutions must start with long-term consumer education about the need to combine landfill, incineration and recycling.

On-line seal integrity

The issue of assuring seal integrity of aseptic products on-line was raised by Dr. Theodore P. Labuza of the University of Minnesota, 1988-89 president of the Institute of Food Technologists, in a recent interview with *Food Engineering* (July '88). "The biggest [aseptic] problem right now, which will impact on present products as well as on low-acid particulates, is that we don't have very good on-line ability to assure seal integrity, as we do on canning lines," said Labuza.

Timothy P. Flagg, national sales manager for TapTone division of Benthos Corp. (North Falmouth, MA), confirms that on-line seal inspection of aseptic products in rigid plastic containers with membrane seals is a problem, based on the many inquiries he has received from food processors and packaging equipment/material suppliers involved in aseptic packaging. TapTone has historically supplied on-line inspection equipment for cans and jars but has focused more recently on inspection systems for aseptic and flexible packaging, said Flagg. TapTone has developed two systems for on-line inspection of aseptic-container seals:

- The *Puffer-Profiler*, adapted from a sys-



Rigid barrier-plastic food containers will grow by more than 800 percent between 1987 and 1992, according to this projection. Hot-filled acid products will dominate. (Source: GE Plastics Group, General Electric Co.)

tem originally developed for General Foods' *Crystal Light* dry beverage-mix container. The Puffer applies heat to expand air or other gases in the headspace of the container, creating a bulge or "puff" in the flexible lid if the seal is good. No puff indicates a leaker. The Profiler is an electromagnetic sensor which measures the shape of the lid: Concave indicates a good seal, flat is a leaker. A mechanical-roller lid-depressor has been added to double-check for leaks. A rejector arm activated by the Profiler pushes leakers to a reject conveyor. TapTone is building a Puffer-Profiler system for on-line inspection of rigid plastic aseptic containers at a conveyor-belt speed of 80 ft. per minute, or about 240 cpm.

• *The Seal Integrity Tester* (SIT), originally developed for the Campbell soup-bowl container and targeted specifically at plastic containers with flexible-membrane closures. This system creates an enclosed chamber around the seal junction of the container and forces compressed air into the chamber. In this case, a puff in the lid indicates a leaker. A sensor above the line detects lid movement and signals a reject. One SIT currently operates at a line speed of 100 cpm.

Retortable plastic containers are more difficult to inspect. The technologies described above can't be applied because of their rigid metal closures, and the principles applied to can inspection won't work either because electromagnetic stress is absorbed by the plastic container and not conducted to the lid, Flagg explained. So TapTone is developing a rotary system with multi-head inspec-

This conflict has focused scientific and regulatory attention on plant sanitation; monitoring for microbiological contamination through hazard analysis of critical control points (HACCP); maintaining tight refrigeration control and monitoring time/temperature conditions throughout distribution; and developing faster microbiological tests using gene probes and enzyme immunoassays.

These trends will continue through the 1990s. "Packaging techniques for these [extended shelf life] products must be designed with a wary eye to the safety of these products," said Dr. Catherine E. Adams of USDA's Food Safety & Inspection Service (FSIS) at the Fresh Pack '88 conference January 20 in Chicago.

"Nearly all of the important foodborne microbial pathogens, with the exception of molds, are able to grow at various rates under modified-atmosphere conditions," warned Dr. Constantin A. Genigeorgis, professor of food safety at the University of California (Davis), at Pack Alimentaire. Risks can be minimized, he continued, by:

1.) Using ingredients with low counts of pathogenic bacteria.

2.) Use and continuous monitoring of thermal processes.

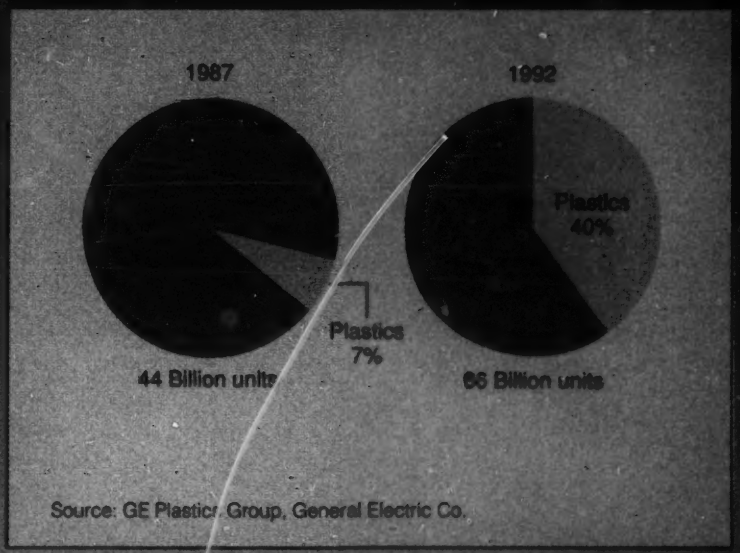
3.) Avoiding post-processing recontamination just prior to packaging.

4.) Strict adherence to low storage temperatures—as close as possible to 0°C.

5.) Formulating products to inhibit microbial growth in case of temperature abuse: for example, applying acidification, reduced water activity, antimicrobials and microbial competitors.

6.) HACCP throughout the processing, distribution and storage chain.

Needed, Genigeorgis added: better ways to



Barrier plastics for convenience foods are projected to grow explosively in the 1990s. (Source: GE Plastics Group, General Electric Co.)

New microwave packages incorporating susceptor, reflector and field-modifying materials, however, can reach temperatures of 400-500°F, with localized heating approaching 600 degrees in some cases. Rising temperatures can cause migration of low molecular-weight compounds from the package to food. Under a strict definition of the Food, Drug & Cosmetic Law, any food product that contains contaminants from the package which are not approved food additives or GRAS is considered adulterated and subject to recall (although this has never happened).

FDA is concerned about what happens to the integrity of both food and package at these temperatures and has started to investigate the question, Risch reported. Although a test employing gas chromatography and mass spectrometry has been developed to detect, identify and quantify migrants from packaging materials, there is still a problem in identifying everything given off by the package. Another problem is finding a test medium to accurately simulate the food product: Foods themselves give off many volatile components that obscure the GC profile of the package.

Meanwhile, the burden of proof that a package is safe for its intended use conditions rests with the manufacturer. If existing regulations do not cover these, it is important to develop a viable test. In this case, Risch recommends contacting FDA for suggestions concerning appropriate tests.

Said Risch: "There is no doubt that there are concerns now which will lead to regulations in the future."

Microwave concerns

Regulatory concerns about microwaveable packaging materials were discussed at Pack Alimentaire by Dr. Sara J. Risch of R&R Analytical, Inc. (St. Paul, MN). "The main regulatory issues are what the package is made of, and what happens to components of the package during microwave heating," Risch observed.

Traditionally, Risch pointed out, the microwave oven was used only to heat or reheat food. The package was heated only by conduction from the food and rarely reached temperatures above 212°F. The Code of Federal Regulations covers only packaging materials used up to or slightly above 212°F, specifying the total amount of non-volatile components that can be extracted by a food simulant.

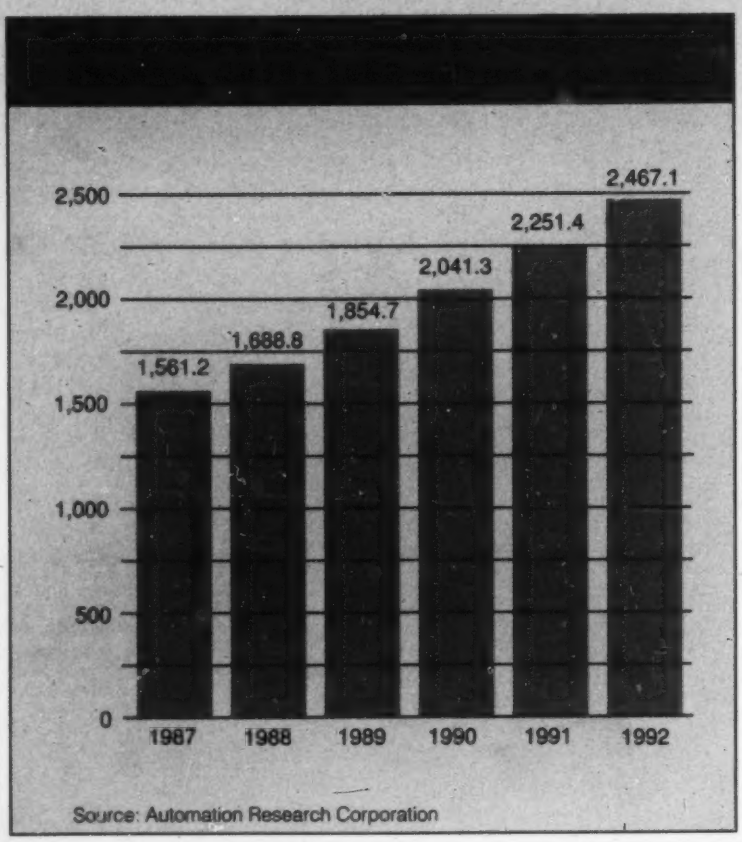
ON DECK: MORE PROCESS CONTROL

The food industry will be changing how it operates. Processing procedures will probably not change much in the next decade but more automation in the form of process control is definitely around the corner.

MARGIE J. RUSSELL
Technical Editor

Looking into the next decade, processing procedures and applications will probably not change drastically. Food products have always and will continue to be mixed, baked, cooked, heated, and cooled under a variety of conditions. *That* much will most likely not change.

Existing processing technologies will probably be improved. However, *how* the processing steps are completed will change proportionately as automation in the form of process control and information systems grows.



Source: Automation Research Corporation

One of the main issues of processing and process control which will be carried into the next decade is that of production consistency. There is a need for processors to make a consistent product; deviations indicate poor management and poor quality control.

Another major issue in the processing area is a greater need for flexibility. Machinery and processing conditions should be available for changes; it is always vital to meet consumers' needs. Market share, too, is becoming more important. Competition is keen and some areas of the food industry experience rapid growth while some experience slow growth. There constantly seems to be a push for specialty items.

To meet these issues planning is needed. Process control makes the entire business/manufacturing scenario more effective. Production variables are controlled by automation and there is effective presentation of information as to how personnel, raw materials, and equipment are being used to produce a product.

The impact of automation on the food industry will get larger in the next decade. Automation Research Corporation, (ARC) Medfield, MA reports the U.S. market for factory management systems was worth in excess of $1.5 billion in 1987. ARC expects the shipments of factory management systems to grow at an average annual rate of approximately 10 percent through 1992, when the market will reach a value of $2.5 billion.

Currently, on the hardware side, factory management systems consist of cell controllers, personal computers, supermicros, and superminis. In 1987, approximately $40 million worth of cell controllers were shipped to manufacturers. The cell controller, combining the ruggedness of a programmable logic controller and the power of a computer, is the highest type of a factory management

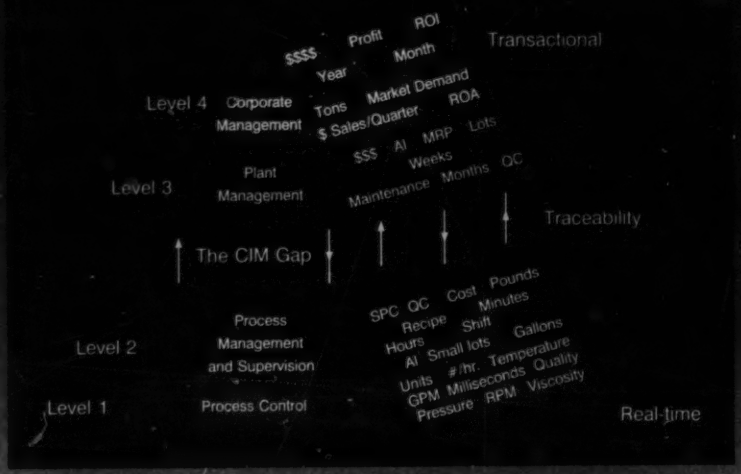


Diagram: Coopers and Lybrand, New York, NY.

system. ARC projects that $210 million worth of cell controllers are expected to be shipped in 1990.

An industry viewpoint

The next progressive step in the process control area for the food industry now that the industry has implemented some forms of automation is the area of sensors, according to Joseph J. Barba, Manager of CIM and Factory Automation Practice, Coopers and Lybrand, New York, NY. "Sensors are becoming more sophisticated. Suppliers are beginning to understand what is needed," Barba explains. "They want to support the

Artificial intelligence techniques in processing applications

Researchers in Artificial Intelligence (AI) have developed numerous programming techniques that increasingly are being incorporated into business. However, use of AI techniques in process industries is still in the "let's try it because it's new" stage.

When discussing AI, there are two very different definitions to consider. A clear distinction must be drawn between a.) artificial intelligence as the *goals* of researchers in computer science, and b.) AI as the *computer techniques* that have been created during their quest. In many instances, AI technologies have facilitated the development of software that automates tasks previously too costly to attempt.

AI techniques were developed to solve classes of problems that were not readily solvable using functional programming methods or mathematical methods. In a processing application problem, AI techniques might be worth investigating if:

- The mathematics of the problem are undefined
- Operator experience is important
- Operator input is an important control parameter
- The control strategy changes frequently
- Complex judgments affect process performance.

All of these are examples where a greater degree of knowledge added to the control system potentially could have important payback. Each has a converse. AI techniques may not be of use if the problem is well characterized mathematically and little operator input is required.

Always, the first step is to identify important problems, and by important we mean that solving these problems would yield major benefits to the process plant owners. The best people are those thoroughly familiar with all of the process plant operations and economics and in many instances there are few people that knowledgeable.

The second step is to identify the causal factors leading to the problem. In most instances there is a causal chain that contributes to a problem rather than an isolated source. And, having identified the problem, it is now time to choose a solution.

Over the past several years, a synthesis of methodologies has resulted in "the method" which can be broken down into: functional analysis, data analysis, knowledge analysis, and business analysis. (See figure at right.) The method does not guarantee success but it does provide a framework which we have found useful for developing alternative solutions.

In functional analysis, the first step is to take the problem with all of its causal links and break it down into a set of discrete functions or tasks. In data analysis, a brief description is developed for each task concerning its inputs, outputs, and sources of control.

For each task in knowledge analysis, an analysis is done of the relationship between the inputs and the outputs of the task. A transfer function may be sufficient to describe the relationship. From an AI point of view, the most interesting tasks are those for which no transfer function can be written.

In business analysis, each of the tasks should be characterized as to its importance to the business aspects of the problem.

For each potential solution, "the method" should provide the informa-

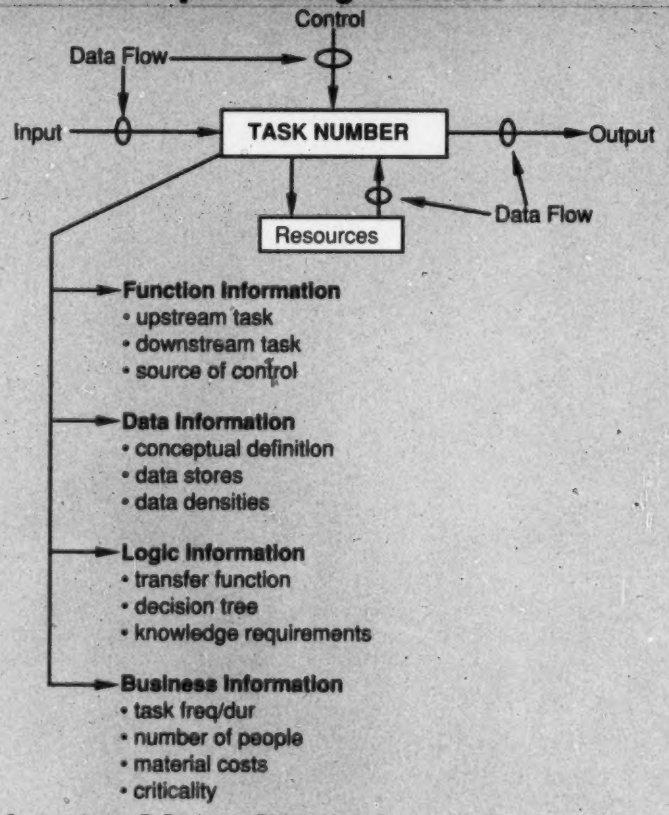
tion required to assess the business impact of a given change. The only additional factors needed are the estimated costs of implementing a given solution.

The following is a list of apothegms for successfully using AI techniques:

- A good business case is the single most important factor in determining project success.
- The most successful AI systems are tightly integrated with traditional computer systems.
- The quality of the knowledge being encoded using AI techniques is the primary determinant of value.
- The greatest ROIs arise from using technology to do things differently, now simply faster.
- Success requires all the traditional programming skills plus mastery of the new AI techniques.

James R. Davis, Combustion Engineering, Inc., Windsor, CT, and Eli Nisenfeld, Combustion Engineering, Inc., Riderwood, MD, from a paper presented at the ISA/FPID Spring Symposium, April 1988, Minneapolis, MN.

An information flow system used to provide processing solutions



Source: James R. Davis and Eli Nisenfeld, Combustion Engineering Inc., Windsor, CT